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REPEATED VERBAL INTERRUPTIONS DURING EXPOSURE TO COMPLEX TRANSCEREBRAL MAGNETIC FIELDS ELICIT IRRITABILITY: IMPLICATIONS FOR OPIATE EFFECTS [1]

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Summary.—Men ($n = 17$) and women ($n = 18$) listened to a brief narrative and then were exposed for 30 min. to a control condition or to a weak (1 microTesla) complex magnetic field applied over the left hemisphere, the right hemisphere, or bilaterally. The subjects were interrupted intermittently to report their thoughts during this period. Because the wave structure of the field had been shown to elevate nociceptive thresholds and to simulate the effects of morphine in rats, we predicted that the group who received the bilateral stimulation should report greater irritability because of their disrupted pleasant experiences. The results supported this hypothesis.

Irritability, a form of aggression, may be enhanced when positive reinforcement is disrupted. The phenomenon can be observed in rats, e.g., sudden extinction of a continuous reinforcement schedule, and in human beings, disruption of an ongoing pleasurable experience. Our experiments with rats and human beings have suggested that the bilateral (hemispheric) presentation of a burst-firing magnetic field for 1 sec. once every 4 sec. may evoke an opiate-like response. Nociceptive thresholds are increased in rats (Fleming, Persinger, & Koren, 1994) and aggressive language is displayed by humans when the experiences are disrupted (Richards, Persinger, & Koren, 1993).

METHOD

The present experiment was designed to integrate both of these concepts. Were bilateral application of these fields pleasurable, intermittent interruption of a subject during the application should produce very specific increases in irritability. To test this hypothesis (following approval of the project by the departmental ethics committee) a total of 35 volunteers (17 men, 18 women), 19 to 25 years of age, participated in the experiment for a 2% bonus mark in a first-year university course. The experiment was a double-blind design. Neither the experimenter nor the subjects knew the purpose of the study; both were told that it involved the effects of magnetic fields upon memory.

On the day of the experiment, each subject sat in a comfortable chair

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within a darkened acoustic chamber. A 5-min. narrative, called the Billy Story (Dittburner & Persinger, 1993), was presented by audiotape. From the beginning of the story and during the subsequent 30 min., the subjects received continuously one of four conditions: no magnetic field, a field over the left temporoparietal region, a field over the right temporoparietal region, or a field over both regions bilaterally. There were similar numbers ($n = 4$ to 5) of men and women per treatment. The subjects were told that they would be asked aperiodically about the content of their thoughts and that these would be kept confidential.

Characteristics of the wave structure and the technical generation of the magnetic fields have been published elsewhere (Richards, *et al.*, 1993). Essentially the fields (1 microT) were generated at any given time from one of four pairs of solenoids that were imbedded into a motorcycle helmet so that the field passed through the brain along the temporoparietal plane. The burst-firing field was rotated to each of the different pairs of solenoids once every 0.5 sec. (one cycle = 2 sec.). The presence and strength of the field over the appropriate regions were verified by a field meter sensitive to 10 nT.

During the 30 min. following the presentation of the story, each subject was interrupted variably once every 2 to 3 min. by the experimenter's voice and was asked to report whatever thoughts were occurring at that moment. The reports were recorded and then classified as (1) alien abduction themes, (2) sexual abuse themes, (3) details of the story, (4) mundane or personal thoughts, or (5) "nothing."

Results

At the end of the 30-min. period, the subject was asked to complete our standard Exit Questionnaire that requests ratings of the relative incidence (0 = never; 1 = at least once; 2 = frequently) of 20 experiences that commonly occur in this context. They range from feelings of detachment to the sense of a presence and have been listed previously (Ruttan, Persinger, & Koren, 1990). Two-way analyses of variance for each of the 20 items by sex and hemispheric treatment were completed. Three-way analyses of variance as a function of the numbers of different types of thoughts (a repeated measure, maximum of 10), sex, and hemispheric treatment were also completed. All analyses involved SPSS software on a VAX 4000 computer.

According to the two-way analyses of variance, only the one item out of the 20 items of the Exit Questionnaire that refers to experience of irritability during the treatment exhibited statistically significant treatment differences ($F_{3,28} = 3.56$, $p < .05$; $eta = 0.51$). To ensure specificity, the irritability score was divided by the mean for all 20 items. Two-way analysis of variance verified the treatment effect ($F = 3.36$, $p < .05$; $eta = 0.46$). There were neither statisti-

cally significant sex differences ($F_{1,28} < 1.50$) nor interactions between treatments and sex ($F_{3,28} < 1.00$) for either measure. *Post hoc* analyses indicated that the source of the main treatment effect between the types of field application was the enhanced irritability during disruption of bilateral stimulation compared to disruption either during the sham field presentation or during the left-hemispheric stimulation.

The means and standard deviations for the raw scores for the sham, left-hemispheric, right-hemispheric, and bilateral stimulation groups for the ratings were 0.0, 0.0; 0.0, 0.0; 0.3, 0.4; and 0.7, 0.8, respectively. The means and standard deviations for the proportional scores, calculated by dividing the score for irritability by the mean score for all 20 items of the Exit Questionnaire, were 0.0, 0.0; 0.0, 0.0; 0.5, 1.0; and 1.1, 1.4, respectively. Given the anomalous variance, nonparametric analyses were completed. A Kruskal-Wallis analysis verified the statistical significance between the groups for both raw scores ($\chi_3^2 = 8.85$, $p < .05$) and the proportional score.

The means and standard deviations for the percentages of episodes (during the 10 disruptions for each subject during the 30-min. exposure) that the subjects reported for various themes were for details of the story 30% ($SD = 24\%$) of the time, for alien abduction themes 4% (7%) of the time, for mundane or individual details 51% (27%) of the time, and for "nothing" 15% (13%) of the time. Less than 1% of the total responses ($N = 350$) for all subjects, i.e., 35 subjects multiplied by 10 responses each, to the interruptions involved "sexual abuse themes" within this context. There were no statistically significant differences for these measures by treatments or sex; however, it may be of interest in light of previous studies (Persinger & Richards, 1991) that the report of alien abduction themes by men who received the left-hemispheric stimulation approached statistical significance ($0.05 < p < 0.10$).

The results supported our hypothesis. We suggest that bilateral application is required to induce an effect which might be considered so pleasant that interruption is nonpleasant and hence induces irritability. Additional support for this explanation has been the increased mood and decreased depression exhibited (according to norm-referenced psychometric instruments) by clinical patients who were exposed to a comparable field configuration for 30 min. once per week for six weeks (Baker & Persinger, in preparation).

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